Personal Protective Equipment and Other Control Options

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Section A

Introduction
Opportunities for Control

source - transmission - receptor

Source: Peter Lees
Personal Protective Equipment

- Many kinds
  - Respirators
  - Clothing
  - Hard hats
  - Safety shoes
  - Face shields

- Continued
  - Hearing protectors
  - Gloves
  - Safety glasses
Use and Misuse of PPE

- Personal protective equipment is widely used
- Frequently inappropriate application or wrong equipment
- Specification of wrong PPE may result in higher exposure than use of no PPE
- Must know proper uses and limitations
## Time Required for Solvent to Penetrate 1/1000 inch of Material

<table>
<thead>
<tr>
<th>Protective Material</th>
<th>1,2-dichloromethane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyl Rubber</td>
<td>6.4 min</td>
</tr>
<tr>
<td>Neoprene rubber latex</td>
<td>0.9 min</td>
</tr>
<tr>
<td>Nitrile rubber latex</td>
<td>0.3 min</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>1.2 min</td>
</tr>
<tr>
<td>Surgical rubber latex</td>
<td>0.2 min</td>
</tr>
<tr>
<td>Viton</td>
<td>82 min</td>
</tr>
</tbody>
</table>
PPE and Training
PPE Performance over Time

![Graph showing mean attenuation over frequency for different time periods: Pre-Task, During-Task, and Post-Task.](image)

- **Mean Attenuation (dB)**
- **Frequency (Hz)**: 125, 250, 500, 1000, 2000, 4000, 8000

- **Pre-Task**: Lines labeled with 'A', 'B', 'C' indicate different levels of mean attenuation.
- **During-Task**: Lines with similar labels as Pre-Task show slight variations.
- **Post-Task**: Lines continue to show trends similar to Pre-Task with slight fluctuations.
PPE Certification Tests

- A primary influence on the design and performance of PPE is conformance with the requirements of the certification tests

Source: NIOSH
### PPE in Laboratory Test vs. Field

<table>
<thead>
<tr>
<th>Type of protector</th>
<th>Median noise reduction ratings&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Protection obtained by lowest 10% in field&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Laboratory</td>
<td>Field</td>
</tr>
<tr>
<td>All earplugs</td>
<td>28</td>
<td>13</td>
</tr>
<tr>
<td>Prefromed types</td>
<td>29</td>
<td>7</td>
</tr>
<tr>
<td>Acoustic wool</td>
<td>26</td>
<td>10</td>
</tr>
<tr>
<td>Custom-molded&lt;sup&gt;c&lt;/sup&gt;</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>Acoustic foam</td>
<td>36</td>
<td>20</td>
</tr>
</tbody>
</table>

<sup>a</sup>Measurements in dB.

<sup>b</sup>Average noise reduction achieved by the 10 percent of workers who obtained the poorest noise protection.

<sup>c</sup>In one plant, the custom-molded earplugs were fabricated by the plant nurse; in the other plant, they were fabricated by the manufacturer.

Source: U.S. Government
The *Real* Problem with PPE

**Workers’ reports of reasons for not wearing hard hats:**

<table>
<thead>
<tr>
<th>Reason</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>852</td>
<td></td>
</tr>
<tr>
<td>Thought it was not needed</td>
<td>216</td>
<td>25</td>
</tr>
<tr>
<td>Not available from employer</td>
<td>176</td>
<td>21</td>
</tr>
<tr>
<td>Not normally used or not practical</td>
<td>471</td>
<td>55</td>
</tr>
<tr>
<td>Uncomfortable, did not fit with other equipment</td>
<td>163</td>
<td>19</td>
</tr>
<tr>
<td>not fit with it on, or in bad condition</td>
<td>163</td>
<td>19</td>
</tr>
<tr>
<td>Other</td>
<td>42</td>
<td>5</td>
</tr>
</tbody>
</table>

Source: U.S. Government
Summary of PPE Limitations

- Must match PPE to the hazard
- Actual performance is always less than that claimed by manufacturer or indicated by testing
  - Considerable variability among manufacturers
- Comfort and ease of use is important
Summary of PPE Limitations

- Training in proper use of PPE is required to achieve maximum possible protection
- PPE designed to pass certification test
  - Need to know limitations of tests
- If PPE isn’t used, it doesn’t work
Section B

Respiratory Protection
Respiratory Protective Equipment

- Protect the respiratory system from inhalation of airborne contaminants by removing contaminants from the air before they are inhaled
- Supplying an independent source of “clean” air
- Viewed as control method of last resort in the hierarchy of controls
Legitimate Uses of Respiratory Protection

- Emergency situations
  - Spill clean-up
- Short-term solutions where engineering controls not feasible
  - Asbestos removal jobs
- While controls being installed
Types of Respirators

- Air-purifying respirators
  - Particulate-removing
    - Positive or negative pressure within the mask
  - Gas-and-vapor-removing
    - Positive or negative pressure within the mask
- Single or multiple use
Types of Respirators

- Atmosphere-supplying respirator
  - Higher level of protection than air-purifying respirator
- Types
  - Hose mask
  - Air line
  - Self-contained breathing apparatus
Air-Purifying Respirator

- Air-purifying elements appropriate to contaminant (filter or adsorbent)
- Operates under negative pressure (seal/leaks)
- Determination of service life

Source: NIOSH
Powered Air-Purifying Respirator

- Air-purifying elements appropriate to contaminant (filter or adsorbent)
- Operates under positive pressure (seal/leaks)
- Determination of service life (and associated limitations)

Source: NIOSH
Air Line Respirator

Source: NIOSH
Self-Contained Breathing Apparatus

- Flow regime
  - Demand
  - Pressure demand
  - Continuous flow
Protection Factors

- Respirator performance rated by protection factor
- Determined for respirator type

\[ PF = \frac{[\text{contaminant}_{\text{outside}}]}{[\text{contaminant}_{\text{inside}}]} \]
Protection Factors

Example

- Workplace air concentration 50 ppm benzene
- Inside respirator 2 ppm benzene

\[
PF = \frac{50 \text{ppm}}{2 \text{ppm}} = 25
\]
Comparison of Protection Factors

<table>
<thead>
<tr>
<th>Respirator Type</th>
<th>PF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half-mask air-purifying</td>
<td>10</td>
</tr>
<tr>
<td>Half-mask powered air-purifying</td>
<td>50</td>
</tr>
<tr>
<td>Half-mask air-line (demand)</td>
<td>10</td>
</tr>
<tr>
<td>Half-mask air-line (continuous flow)</td>
<td>50</td>
</tr>
<tr>
<td>Half-mask air-line (pressure demand)</td>
<td>1000</td>
</tr>
<tr>
<td>Full-face piece air line (pressure demand)</td>
<td>2000</td>
</tr>
<tr>
<td>SCBA (pressure demand)</td>
<td>10,000</td>
</tr>
</tbody>
</table>
Section C

Respiratory Protection Programs
Respirator Programs

- OSHA requires written programs defining the procedures by which respiratory protective equipment is selected, stored, maintained, and repaired.
- Procedures for determining if persons required to wear respiratory protective equipment are medically fit, trained in its use, and evaluated.
Respirator Selection

- Select based on hazard
  - Implies identification of hazard and knowledge of its magnitude through investigation/measurement
- Use NIOSH-certified respirators
- Provide sufficient number of respirator models and sizes to fit users
- Respirator Decision Logic
  - www.cdc.gov/niosh/87-108.html
Medical Evaluation

- Required before RPE use
- Evaluation by physician or licensed health care professional
- Questionnaire or examination as specified in 29 CFR 1910.134(e)
- Mandatory exam for positive response to specified questions

Source: NIOSH
Fit Testing

- Qualitative fit tests
  - simple to conduct
  - For PF<100

Source: NIOSH
Fit Testing

- Quantitative fit testing
  - Fit testing booth and associated equipment
  - For PF >100

Source: NIOSH
Training

- Annual; “comprehensive and understandable”
- Selection of respirator
- Inspection of respirator
- Use of respirator
- Cleaning of respirator
- Storage of respirator

Source: NIOSH
Maintenance and Care

- Cleaning and disinfection
- Storage
- Inspection
  - Emergency use
  - Routine use
- Repair

Source: NIOSH